具有 ±15kV ESD 保护功能的 MAX3221 3V 至 5.5V RS-232 线路驱动器和接收器

1 特性

- 使用人体放电模型 (HBM) 时，RS-232 总线引脚 ESD 保护大于 ±15kV
- 符合或超出 TIA/EIA-232-F 和 ITU V.28 标准的要求
- 由 3V 至 5.5V V_{CC} 电源供电
- 运行速率高达 250kbps
- 一个驱动器和一个接收器
- 低待机电流：1 μA（典型值）
- 外部电容器：4 × 0.1 μF
- 接受 5V 逻辑输入及 3.3V 电源
- 备选高速引脚兼容器件 (1Mbps)
  - SNx5C3221
- 自动断电功能可自动禁用驱动器以节省能耗

2 应用

- 工业 PC
- 有线网络
- 数据中心和企业级计算
- 电池供电型系统
- PDA
- 笔记本电脑
- 便携式计算机
- 掌上电脑
- 手持设备

3 说明

MAX3221 器件包含一个线路驱动器、一个具有专用使能引脚的线路接收器和一个具有引脚对引脚（串行端口连接引脚，包括 GND）±15kV ESD 保护功能的双电荷泵电路。该器件符合 TIA/EIA-232-F 的要求并在异步通信控制器与串行端口连接器之间提供电气接口。电荷泵和四个小型外部电容器支持由 3V 至 5.5V 单电源供电。

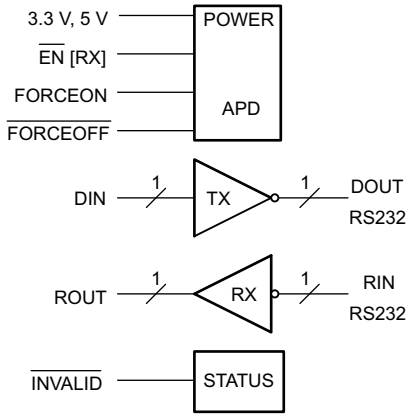
这些器件以高达 250kbps 的数据信号传输速率和最大值为 30V/μs 的驱动器输出压摆率运行。

串行端口处于非活动状态时，可提供灵活的电源管理控制选项。当 FORCEON 为低电平且 $\overline{\text{FORCEOFF}}$ 为高电平时，自动断电功能启用。在这种运行模式下，如果器件在接收器输入端未感应到有效的 RS-232 信号，则会禁用驱动器输出，且电源电流将降低至 1 μA。$\overline{\text{INVALID}}$ 输出会通知用户接收器输入端是否存在 RS-232 信号。

器件信息

器件型号	封装(1)	封装尺寸（标称值）
MAX3221	SSOP (DB) (32)	6.20mm × 5.30mm
	TSSOP (PW) (32)	5.00mm × 4.40mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。



简化图

Table of Contents

4 Revision History

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision O (June 2015) to Revision P (July 2021) — **Page**

- 更改了*应用*列表 1
- Changed the values in the *Thermal Information* table for DB and PW packages 5

Changes from Revision N (January 2014) to Revision O (June 2015) — **Page**

- 添加了*引脚配置和功能*部分、*ESD 等级*表、*特性说明*部分、*器件功能模式*、*应用和实施*部分、*电源相关建议*部分、*布局*部分、*器件和文档支持*部分以及*机械、封装和可订购信息*部分 1

Changes from Revision M (March 2004) to Revision N (January 2013) — **Page**

- 将文档更新为新的 TI 数据表格式 - 无规格变化 1
- 删除了*订购信息*表 1

5 Pin Configuration and Functions

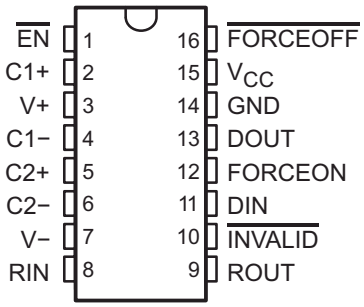


图 5-1. DB or PW Package, 16-Pin SSOP or TSSOP, Top View

表 5-1. Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
C1+	2	—	Positive terminals of the voltage-doubler charge-pump capacitors
C2+	5		
C1 –	4	—	Negative terminals of the voltage-doubler charge-pump capacitors
C2 –	6		
DIN	11	I	Driver input
DOUT	13	O	RS-232 driver output
$\overline{EN}$	1	I	Low input enables receiver ROUT output. High input sets ROUT to high impedance.
$\overline{FORCEOFF}$	16	I	Automatic power-down control input
FORCEON	12	I	Automatic power-down control input
GND	14	—	Ground
$\overline{INVALID}$	10	O	Invalid output pin. Output low when all RIN inputs are unpowered.
RIN	8	I	RS-232 receiver input
ROUT	9	O	Receiver output
V_{CC}	15	—	3-V to 5.5-V supply voltage
V+	3	O	5.5-V supply generated by the charge pump
V –	7	O	– 5.5-V supply generated by the charge pump

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

			MIN	MAX	UNIT
	V_{CC} to GND		–0.3	6	V
	V+ to GND		–0.3	7	
	V– to GND		0.3	–7	
	V+ + |V–|(2)			13	
V_I	Input voltage	DIN, $\overline{EN}$, $\overline{FORCEOFF}$, and FORCEON to GND	–0.3	6	V
		RIN to GND		±25	
V_O	Output voltage	DOUT to GND		±13.2	V
		ROUT to GND	–0.3	V_{CC} + 0.3	
T_J	Junction temperature(3)			150	°C
T_{stg}	Storage temperature range		–65	150	

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the Recommended Operating Conditions but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
(2) V+ and V– can have maximum magnitudes of 7 V, but their absolute difference cannot exceed 13 V.
(3) Maximum power dissipation is a function of $T_J(max)$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A) / R_{\theta JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

6.2 ESD Ratings

				VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	All pins except 8, 13	±3000	V
			Pins 8, 13	±15,000	
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)		±1500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

(see 图 9-1)(1)

				MIN	NOM	MAX	UNIT
	Supply voltage		V_{CC} = 3.3 V	3	3.3	3.6	V
			V_{CC} = 5 V	4.5	5	5.5	
V_{IH}	Driver high-level input voltage	DIN, $\overline{FORCEOFF}$, FORCEON, $\overline{EN}$	V_{CC} = 3.3 V	2			V
			V_{CC} = 5 V	2.4			
V_{IL}	Driver low-level input voltage	DIN, $\overline{FORCEOFF}$, FORCEON, $\overline{EN}$				0.8	V
V_I	Driver input voltage	DIN, $\overline{FORCEOFF}$, FORCEON, $\overline{EN}$		0		5.5	V
	Receiver input voltage			–25		25	
T_A	Operating free-air temperature		MAX3221C	0		70	°C
			MAX3221I	–40		85	

(1) Test conditions are C1 – C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2 – C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

6.4 Thermal Information

THERMAL METRIC[1]		MAX3221		UNIT
		DB (SSOP)	PW (TSSOP)	
		16 PINS	16 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	105.8	110.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	51.9	41.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	57.6	57.2	°C/W
ψ_{JT}	Junction-to-top characterization parameter	14.1	4.2	°C/W
ψ_{JB}	Junction-to-board characterization parameter	56.8	56.6	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

6.5 Electrical Characteristics – Power

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)(2)

PARAMETER			TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
I_I	Input leakage current	$\overline{FORCEOFF}$, FORCEON, $\overline{EN}$				±0.01	±1	µA
I_{CC}	Supply current	Automatic power-down disabled	No load, V_{CC} = 3.3 V to 5 V	No load, $\overline{FORCEOFF}$ and FORCEON at V_{CC}		0.3	1	mA
		Powered off		No load, $\overline{FORCEOFF}$ at GND		1	10	µA
		Automatic power-down enabled		No load, $\overline{FORCEOFF}$ at V_{CC}, FORCEON at GND, All RIN are open or grounded		1	10	µA

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Test conditions are C1 – C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2 – C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

6.6 Electrical Characteristics – Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)(3)

PARAMETER		TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
V_{OH}	High-level output voltage	D_{OUT} at R_L = 3 kΩ to GND,	D_{IN} = GND	5	5.4		V
V_{OL}	Low-level output voltage	D_{OUT} at R_L = 3 kΩ to GND,	D_{IN} = V_{CC}	–5	–5.4		V
I_{IH}	High-level input current	V_I = V_{CC}			±0.01	±1	µA
I_{IL}	Low-level input current	V_I at GND			±0.01	±1	µA
I_{OS}	Short-circuit output current(2)	V_{CC} = 3.6 V	V_O = 0 V		±35	±60	mA
		V_{CC} = 5.5 V	V_O = 0 V		±35	±60	
r_O	Output resistance	V_{CC}, V+, and V– = 0 V	V_O = ±2 V	300	10M		Ω
I_{off}	Output leakage current	$\overline{FORCEOFF}$ = GND	V_O = ±12 V, V_{CC} = 3 V to 3.6 V			±25	µA
			V_O = ±12 V, V_{CC} = 4.5 V to 5.5 V			±25	

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Short-circuit durations should be controlled to prevent exceeding the device absolute power dissipation ratings, and not more than one output should be shorted at a time.
(3) Test conditions are C1 – C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2 – C4 = 0.33 µF at V_{CC} = 5 V ± 0.5

6.7 Electrical Characteristics – Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)(2)

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = –1 mA	V_{CC} – 0.6	V_{CC} – 0.1		V
V_{OL}	Low-level output voltage	I_{OL} = 1.6 mA			0.4	V
V_{IT+}	Positive-going input threshold voltage	V_{CC} = 3.3 V		1.5	2.4	V
		V_{CC} = 5 V		1.8	2.4	
V_{IT-}	Negative-going input threshold voltage	V_{CC} = 3.3 V	0.6	1.1		V
		V_{CC} = 5 V	0.8	1.4		
V_{hys}	Input hysteresis (V_{IT+} – V_{IT-})			0.5		V
I_{off}	Output leakage current	$\overline{FORCEOFF}$ = 0 V		±0.05	±10	µA
r_i	Input resistance	V_I = ±3 V to ±25 V	3	5	7	kΩ

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Test conditions are C1 – C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2 – C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

6.8 Electrical Characteristics – Status

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)(2)

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
$V_{T+(valid)}$	Receiver input threshold for $\overline{INVALID}$ high-level output voltage	FORCEON = GND, $\overline{FORCEOFF}$ = V_{CC}			2.7	V
$V_{T-(valid)}$	Receiver input threshold for $\overline{INVALID}$ high-level output voltage	FORCEON = GND, $\overline{FORCEOFF}$ = V_{CC}	–2.7			V
$V_{T(invalid)}$	Receiver input threshold for $\overline{INVALID}$ low-level output voltage	FORCEON = GND, $\overline{FORCEOFF}$ = V_{CC}	–0.3		0.3	V
V_{OH}	$\overline{INVALID}$ high-level output voltage	I_{OH} = –1 mA, FORCEON = GND, $\overline{FORCEOFF}$ = V_{CC}	V_{CC} – 0.6			V
V_{OL}	$\overline{INVALID}$ low-level output voltage	I_{OH} = –1 mA, FORCEON = GND, $\overline{FORCEOFF}$ = V_{CC}			0.4	V

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Test conditions are C1 – C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2 – C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

6.9 Switching Characteristics – Driver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)(3)

PARAMETER		TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
	Maximum data rate	C_L = 1000 pF, R_L = 3 kΩ, see 图 7-1		150	250		kbps
$t_{sk(p)}$	Pulse skew(2)	C_L = 150 to 2500 pF, R_L = 3 kΩ to 7 kΩ, see 图 7-2			100		ns
SR(tr)	Slew rate, transition region (see 图 7-1)	V_{CC} = 3.3 V, R_L = 3 kΩ to 7 kΩ	C_L = 150 to 1000 pF	6		30	V/µs
			C_L = 150 to 2500 pF	4		30	

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.
(3) Test conditions are C1 – C4 = 0.1 µF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 µF, C2 – C4 = 0.33 µF at V_{CC} = 5 V ± 0.5 V.

6.10 Switching Characteristics – Receiver

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)(3)

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
t_{PLH}	Propagation delay time, low- to high-level output	C_L = 150 pF, see 图 7-3		150		ns
t_{PHL}	Propagation delay time, high- to low-level output	C_L = 150 pF, see 图 7-3		150		ns
t_{en}	Output enable time	C_L = 150 pF, R_L = 3 kΩ, see 图 7-4		200		ns
t_{dis}	Output disable time	C_L = 150 pF, R_L = 3 kΩ, see 图 7-4		200		ns
$t_{sk(p)}$	Pulse skew(2)	See 图 7-3		50		ns

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Pulse skew is defined as $|t_{PLH} - t_{PHL}|$ of each channel of the same device.
(3) Test conditions are C1 – C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2 – C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

6.11 Switching Characteristics – Status

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)(2)

PARAMETER		MIN	TYP(1)	MAX	UNIT
t_{valid}	Propagation delay time, low- to high-level output		1		μs
$t_{invalid}$	Propagation delay time, high- to low-level output		30		μs
t_{en}	Supply enable time		100		μs

(1) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.
(2) Test conditions are C1 – C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2 – C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

6.12 Typical Characteristics

V_{CC} = 3.3 V

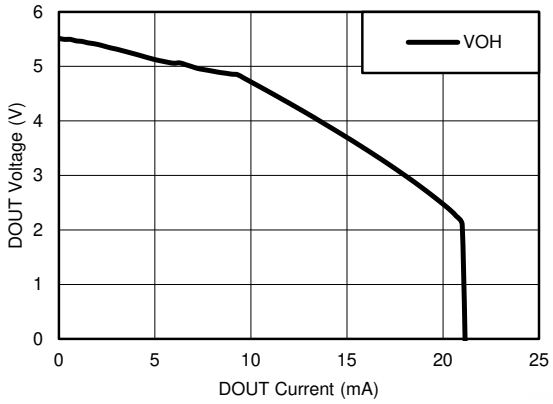


图 6-1. DOUT V_{OH} vs Load Current

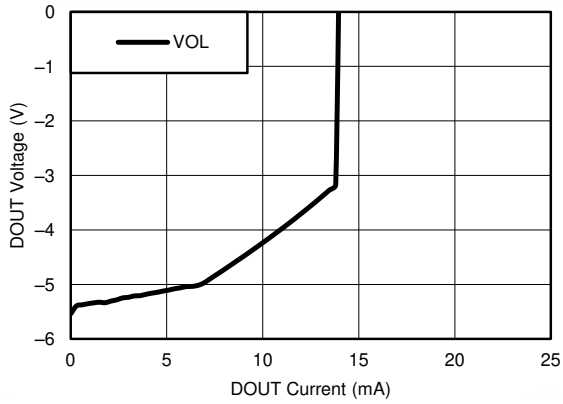
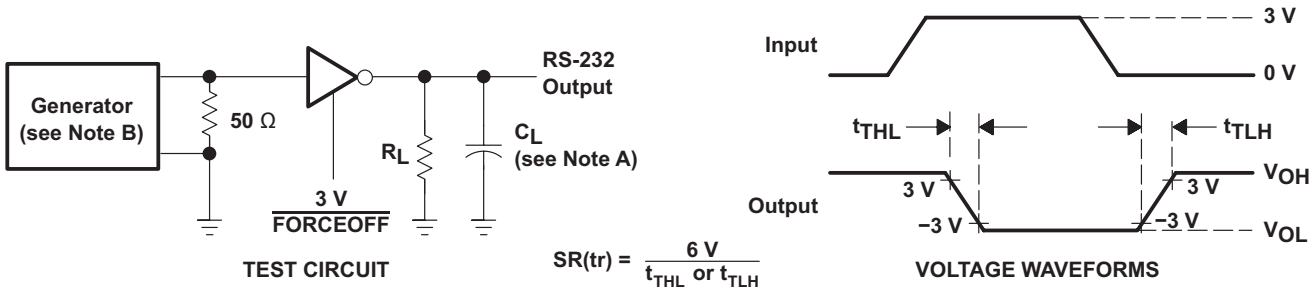


图 6-2. DOUT V_{OL} vs Load Current

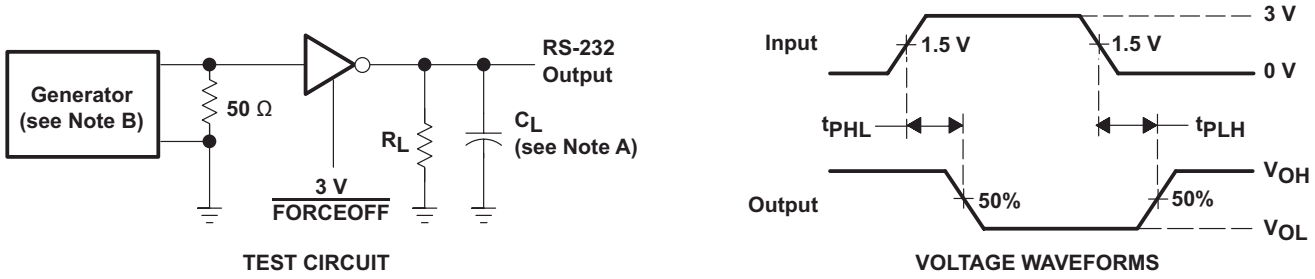
7 Parameter Measurement Information



A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 250 kbps, Z_O = 50 Ω, 50% duty cycle, $t_r \leqslant$ 10 ns, $t_f \leqslant$ 10 ns.

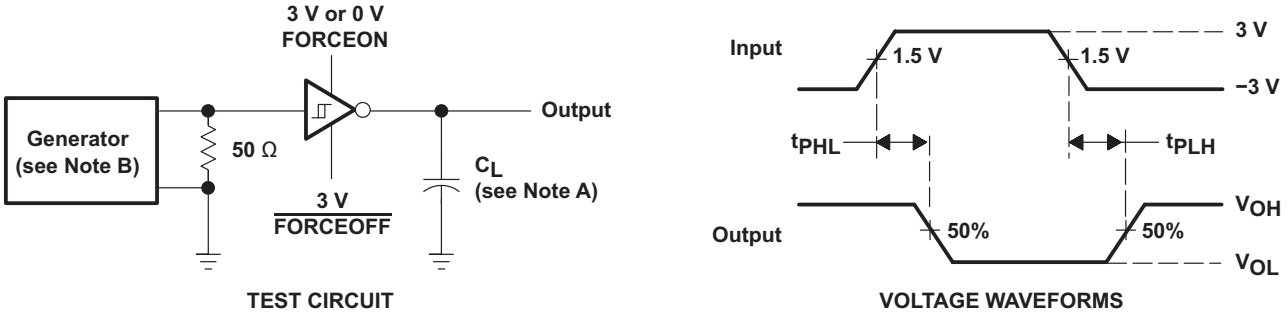
图 7-1. Driver Slew Rate



A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 250 kbps, Z_O = 50 Ω, 50% duty cycle, $t_r \leqslant$ 10 ns, $t_f \leqslant$ 10 ns.

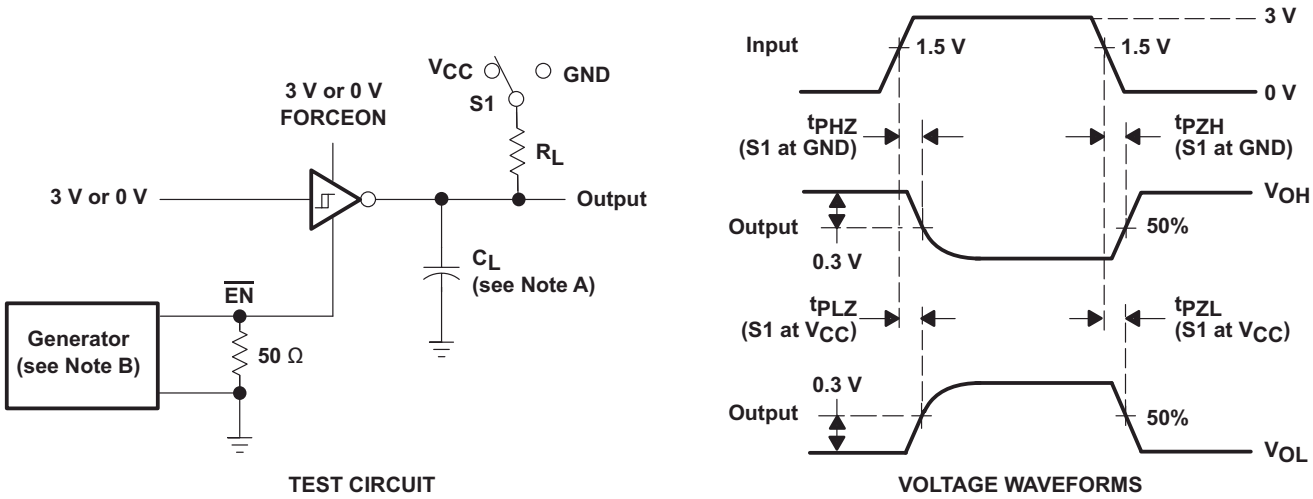
图 7-2. Driver Pulse Skew



A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, $t_r \leqslant$ 10 ns, $t_f \leqslant$ 10 ns.

图 7-3. Receiver Propagation Delay Times



A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: Z_O = 50 Ω, 50% duty cycle, $t_r \leqslant$ 10 ns, $t_f \leqslant$ 10 ns.

C. t_{PLZ} and t_{PHZ} are the same as t_{dis}.

D. t_{PZL} and t_{PZH} are the same as t_{en}.

图 7-4. Receiver Enable and Disable Times

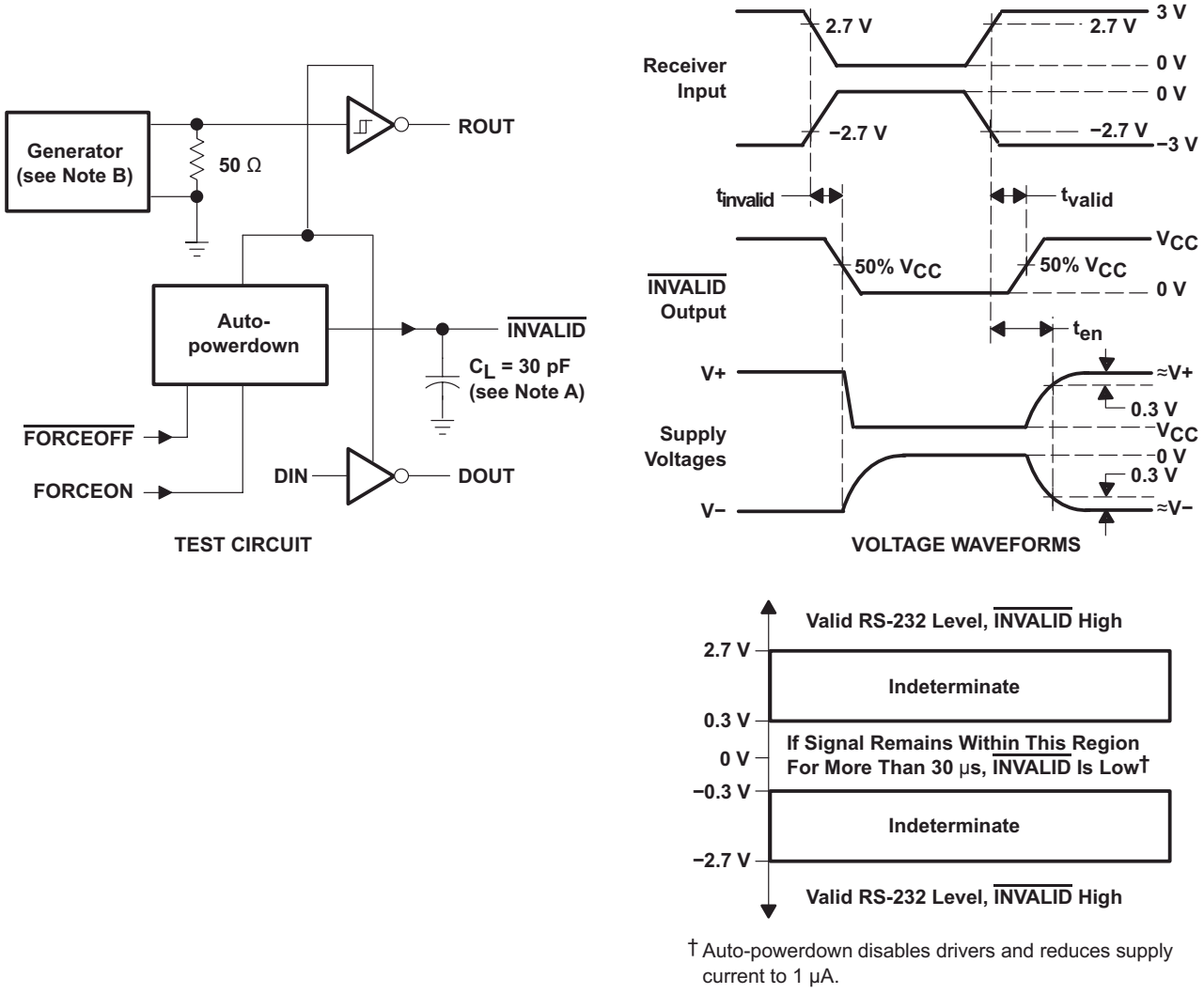


图 7-5. INVALID Propagation Delay Times and Driver Enabling Time

8 Detailed Description

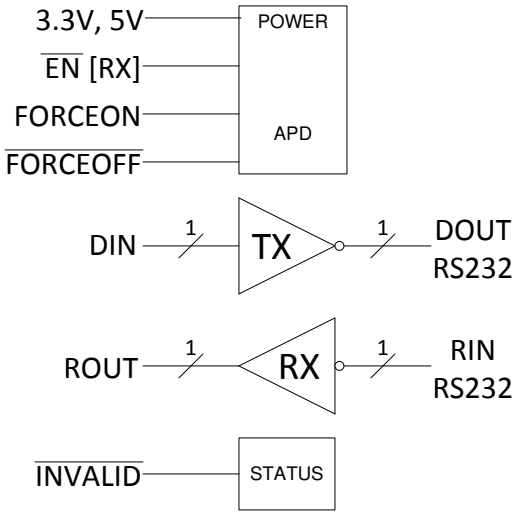
8.1 Overview

The MAX3221 device is a one-driver and one-receiver RS-232 interface device. All RS-232 inputs and outputs are protected to ±15 kV using the Human Body Model. The charge pump requires only four small 0.1-μF capacitors for operation from a 3.3-V supply. The MAX3221 is capable of running at data rates up to 250 kbps, while maintaining RS-232-compliant output levels.

Automatic power-down can be disabled when FORCEON and $\overline{\text{FORCEOFF}}$ are high. With automatic power-down plus enabled, the device activates automatically when a valid signal is applied to any receiver input. The device can automatically power down the driver to save power when the RIN input is unpowered.

$\overline{\text{INVALID}}$ is high (valid data) if receiver input voltage is greater than 2.7 V or less than –2.7 V, or has been between –0.3 V and 0.3 V for less than 30 μs. $\overline{\text{INVALID}}$ is low (invalid data) if receiver input voltages are between –0.3 V and 0.3 V for more than 30 μs. Refer to 图 7-5 for receiver input levels.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 Power

The power block increases, inverts, and regulates voltage at V+ and V- pins using a charge pump that requires four external capacitors. Auto-power-down feature for driver is controlled by FORCEON and $\overline{\text{FORCEOFF}}$ inputs. Receiver is controlled by $\overline{\text{EN}}$ input. See 表 8-1 and 表 8-2

When MAX3221 is unpowered, it can be safely connected to an active remote RS232 device.

8.3.2 RS232 Driver

One driver interfaces standard logic level to RS232 levels. DIN input must be valid high or low.

8.3.3 RS232 Receiver

One receiver interfaces RS232 levels to standard logic levels. An open input will result in a high output on ROUT. RIN input includes an internal standard RS232 load. A logic high input on the $\overline{\text{EN}}$ pin will shutdown the receiver output.

8.3.4 RS232 Status

The $\overline{\text{INVALID}}$ output goes low when RIN input is unpowered for more than 30 μs. The $\overline{\text{INVALID}}$ output goes high when receiver has a valid input. The $\overline{\text{INVALID}}$ output is active when V_{cc} is powered irregardless of FORCEON and $\overline{\text{FORCEOFF}}$ inputs (see 表 8-3).

8.4 Device Functional Modes

表 8-1, 表 8-2, and 表 8-3 show the behavior of the driver, receiver, and INVALID(activelow) features under all possible relevant combinations of inputs.

表 8-1. Driver(1)

INPUTS				OUTPUT	DRIVER STATUS
DIN	FORCEON	$\overline{\text{FORCEOFF}}$	VALID RIN RS-232 LEVEL	DOUT	
X	X	L	X	Z	Powered off
L	H	H	X	H	Normal operation with automatic power down disabled
H	H	H	X	L	
L	L	H	Yes	H	Normal operation with automatic power down enabled
H	L	H	Yes	L	
L	L	H	No	Z	Powered off by automatic power down feature
H	L	H	No	Z	

(1) H = high level, L = low level, X = irrelevant, Z = high impedance, Yes = |RIN| > 2.7 V, No = |RIN| <0.3 V

表 8-2. Receiver(1)

INPUTS			OUTPUT	RECEIVER STATUS
RIN	$\overline{\text{EN}}$	VALID RIN RS-232 LEVEL	ROUT	
X	H	X	Z	Output off
L	L	X	H	Normal operation
H	L	X	L	
Open	L	No	H	

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off), Open = input disconnected or connected driver off

表 8-3. $\overline{\text{INVALID}}$ (1)

INPUTS				OUTPUT
RIN	FORCEON	$\overline{\text{FORCEOFF}}$	$\overline{\text{EN}}$	$\overline{\text{INVALID}}$
L	X	X	X	H
H	X	X	X	H
Open	X	X	X	L

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off), Open = input disconnected or connected driver off

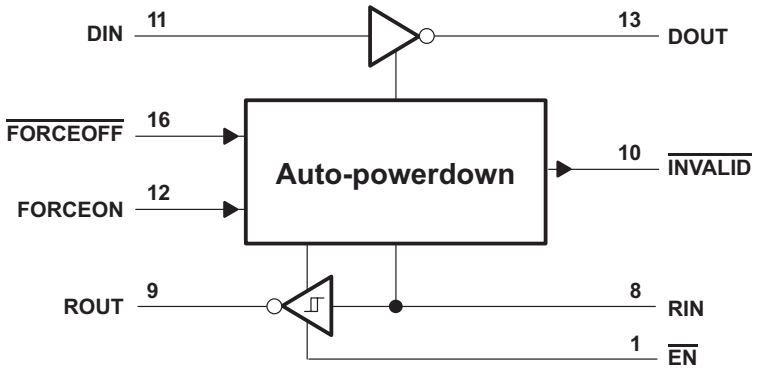


图 8-1. Logic Diagram

9 Application and Implementation

Note

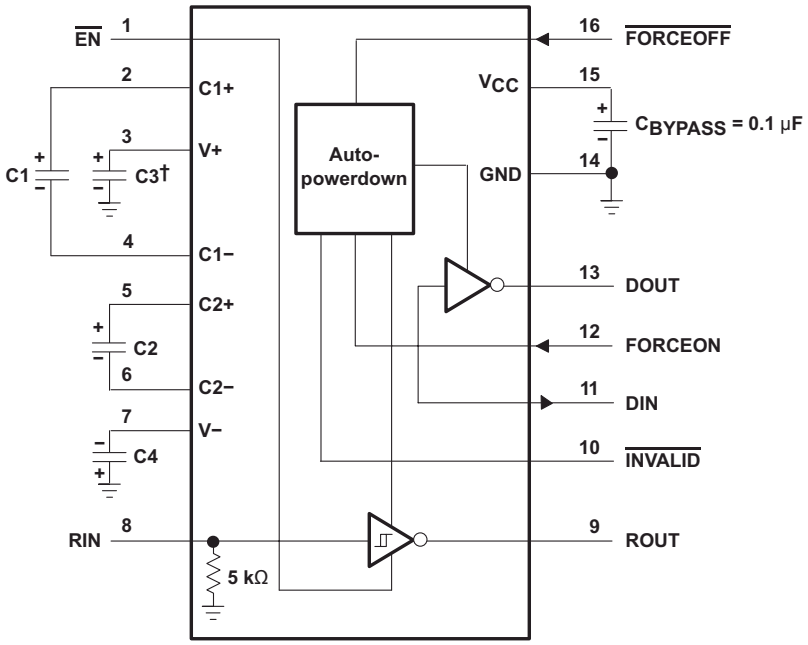
以下应用部分中的信息不属于 TI 器件规格的范围，TI 不担保其准确性和完整性。TI 的客 户应负责确定器件是否适用于其应用。客户应验证并测试其设计，以确保系统功能。

9.1 Application Information

The MAX3221 line driver and receiver is a specialized device for 3-V to 5.5-V RS-232 communication applications. This application is a generic implementation of this device with all required external components. For proper operation, add capacitors as shown in 图 9-1.

9.2 Typical Application

ROUT and DIN connect to UART or general purpose logic lines. FORCEON and $\overline{\text{FORCEOFF}}$ may be connected general purpose logic lines or tied to ground or V_{CC}. $\overline{\text{INVALID}}$ may be connected to a general purpose logic line or left unconnected. RIN and DOUT lines connect to a RS232 connector or cable. DIN, FORCEON, and $\overline{\text{FORCEOFF}}$ inputs must not be left unconnected.



† C3 can be connected to V_{CC} or GND.

NOTES: A. Resistor values shown are nominal.

B. Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

V_{CC} vs CAPACITOR VALUES

V_{CC}	C1	C2, C3, and C4
3.3 V ± 0.3 V	0.1 µF	0.1 µF
5 V ± 0.5 V	0.047 µF	0.33 µF
3 V to 5.5 V	0.1 µF	0.47 µF

图 9-1. Typical Operating Circuit and Capacitor Values

9.2.1 Design Requirements

- Recommended V_{CC} is 3.3 V or 5 V.
  - 3 V to 5.5 V is also possible
- Maximum recommended bit rate is 250 kbps.
- Use capacitors as shown in 图 9-1.

9.2.2 Detailed Design Procedure

- DIN, $\overline{\text{FORCEOFF}}$ and FORCEON inputs must be connected to valid low or high logic levels.
- Select capacitor values based on VCC level for best performance.

9.2.3 Application Curve

Curves for V_{CC} of 3.3 V and 250 kbps alternative bit data stream.

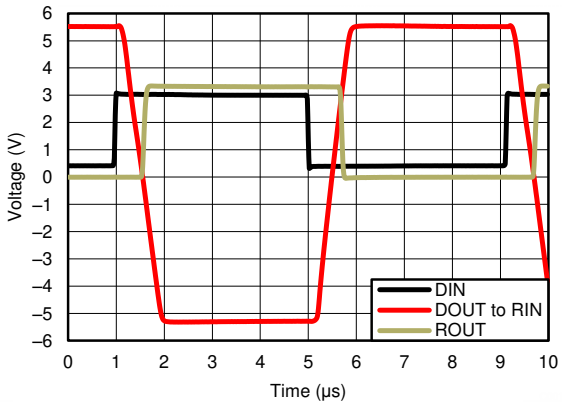


图 9-2. 250-kbps Driver to Receiver Loopback Timing Waveform, V_{CC} = 3.3 V

10 Power Supply Recommendations

TI recommends a 0.1- µ F capacitor to filter noise on the power supply pin. For additional filter capability, a 0.01- µ F capacitor may be added in parallel as well. Power supply input voltage is recommended to be any valid level in *Recommended Operating Conditions*.

11 Layout

11.1 Layout Guidelines

Keep the external capacitor traces short. This is more important on C1 and C2 nodes that have the fastest rise and fall times.

11.2 Layout Example

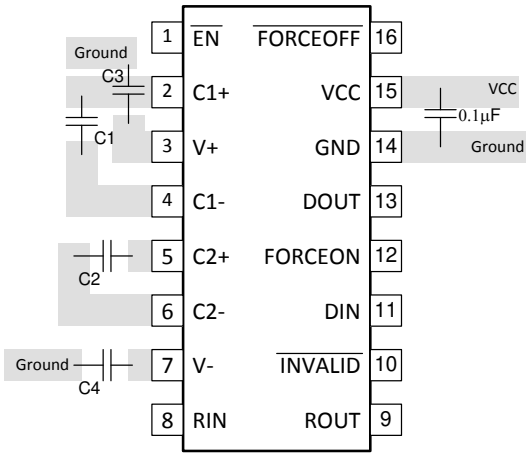


图 11-1. Layout Diagram

12 Device and Documentation Support

12.1 支持资源

TI E2E™ 支持论坛是工程师的重要参考资料，可直接从专家获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题可获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的《使用条款》。

12.2 Trademarks

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12.3 静电放电警告

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ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

12.4 术语表

TI 术语表　　本术语表列出并解释了术语、首字母缩略词和定义。

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
MAX3221CDBR	Active	Production	SSOP (DB) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C
MAX3221CDBR.A	Active	Production	SSOP (DB) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C
MAX3221CDBRG4	Active	Production	SSOP (DB) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C
MAX3221CPWR	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C
MAX3221CPWR.A	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C
MAX3221CPWRE4	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C
MAX3221CPWRG4	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	MA3221C
MAX3221IDBR	Active	Production	SSOP (DB) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I
MAX3221IDBR.A	Active	Production	SSOP (DB) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I
MAX3221IDBRE4	Active	Production	SSOP (DB) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I
MAX3221IDBRG4	Active	Production	SSOP (DB) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I
MAX3221IPWR	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU | SN	Level-1-260C-UNLIM	-40 to 85	MB3221I
MAX3221IPWR.A	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I
MAX3221IPWRG4	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I
MAX3221IPWRG4.A	Active	Production	TSSOP (PW) | 16	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	MB3221I

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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OTHER QUALIFIED VERSIONS OF MAX3221 :

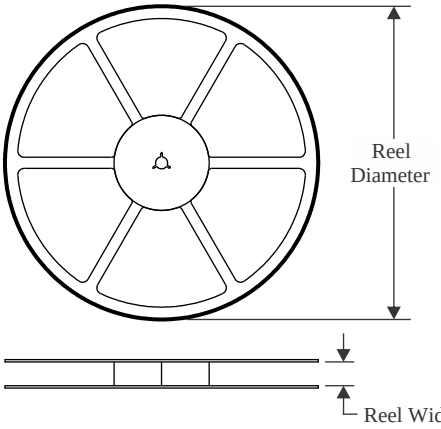
- Enhanced Product : MAX3221-EP

NOTE: Qualified Version Definitions:

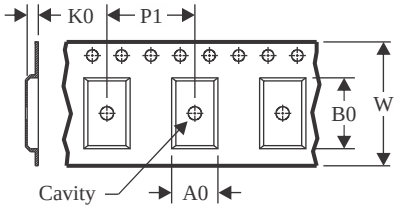
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

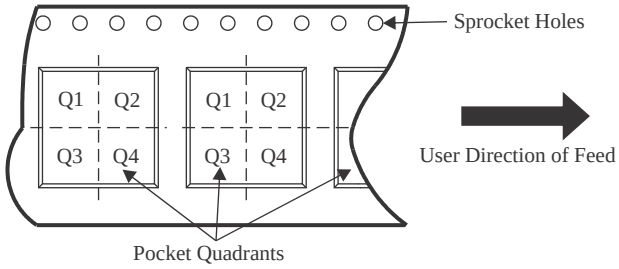


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

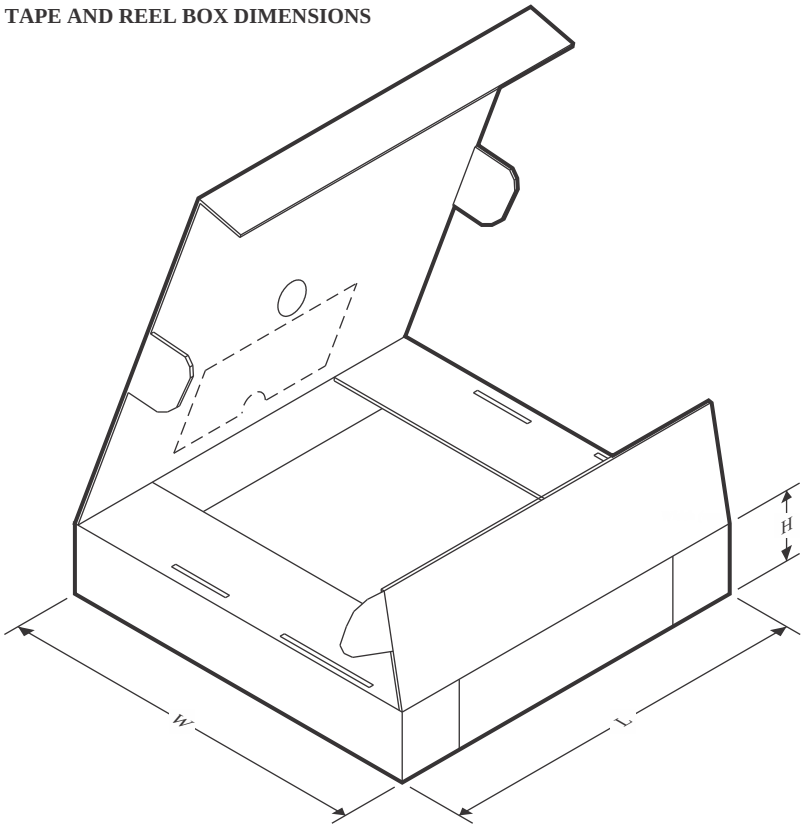
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
MAX3221CDBR	SSOP	DB	16	2000	330.0	16.4	8.35	6.6	2.4	12.0	16.0	Q1
MAX3221CPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221IDBR	SSOP	DB	16	2000	330.0	16.4	8.35	6.6	2.4	12.0	16.0	Q1
MAX3221IPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221IPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.3	1.6	8.0	12.0	Q1
MAX3221IPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221IPWRG4	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
MAX3221IPWRG4	TSSOP	PW	16	2000	330.0	12.4	6.9	5.3	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

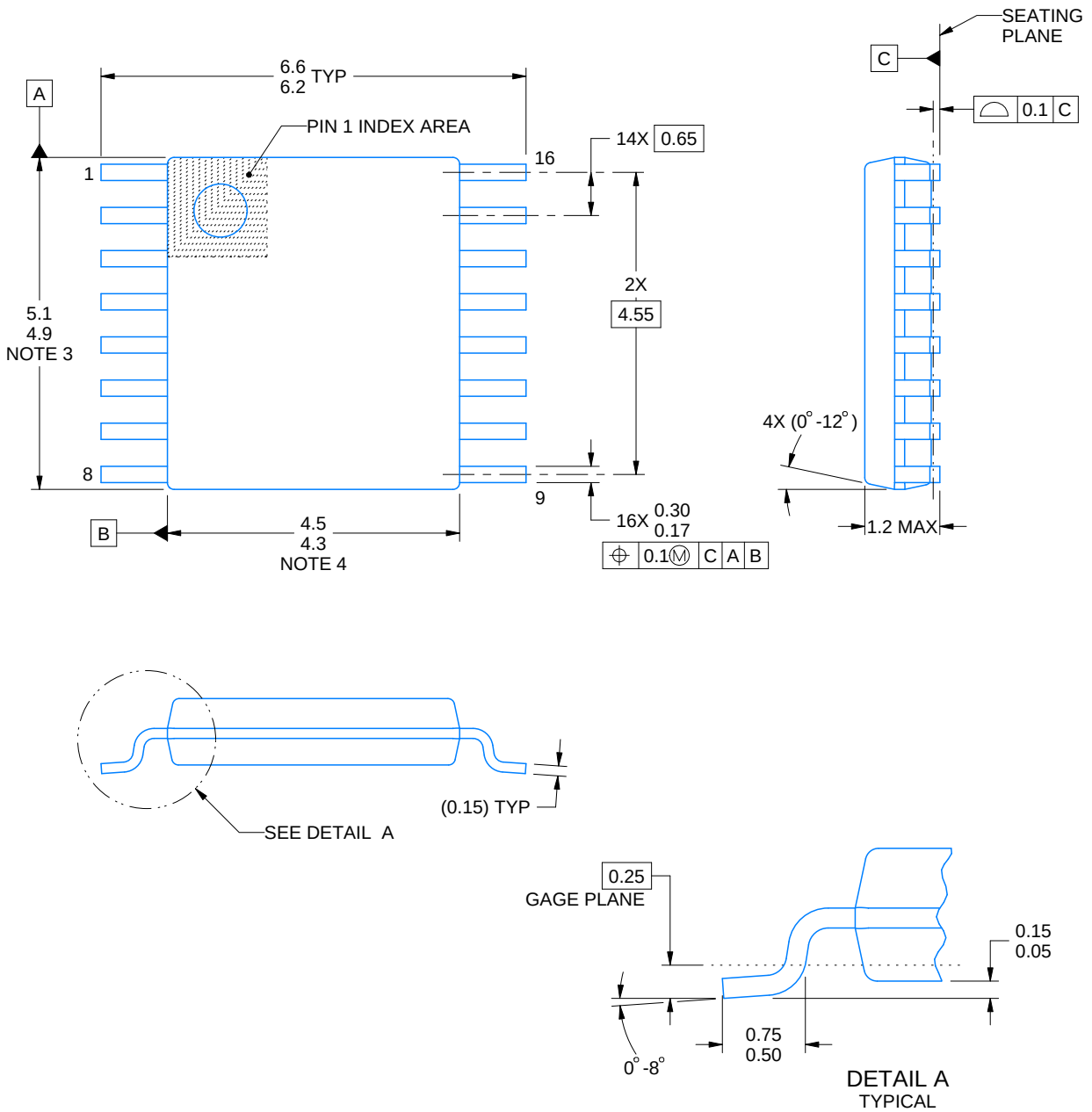
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
MAX3221CDBR	SSOP	DB	16	2000	353.0	353.0	32.0
MAX3221CPWR	TSSOP	PW	16	2000	353.0	353.0	32.0
MAX3221IDBR	SSOP	DB	16	2000	353.0	353.0	32.0
MAX3221IPWR	TSSOP	PW	16	2000	353.0	353.0	32.0
MAX3221IPWR	TSSOP	PW	16	2000	367.0	367.0	35.0
MAX3221IPWR	TSSOP	PW	16	2000	356.0	356.0	35.0
MAX3221IPWRG4	TSSOP	PW	16	2000	353.0	353.0	32.0
MAX3221IPWRG4	TSSOP	PW	16	2000	367.0	367.0	35.0

PACKAGE OUTLINE

PW0016A

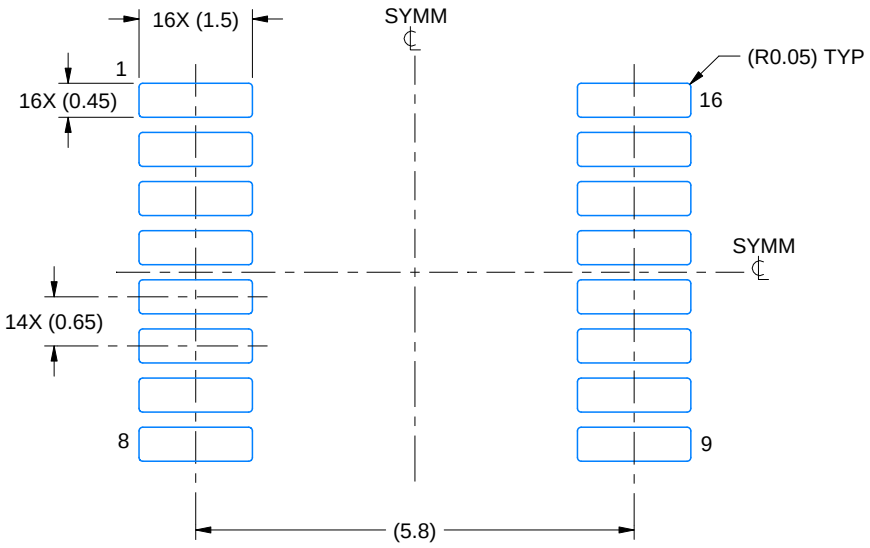
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



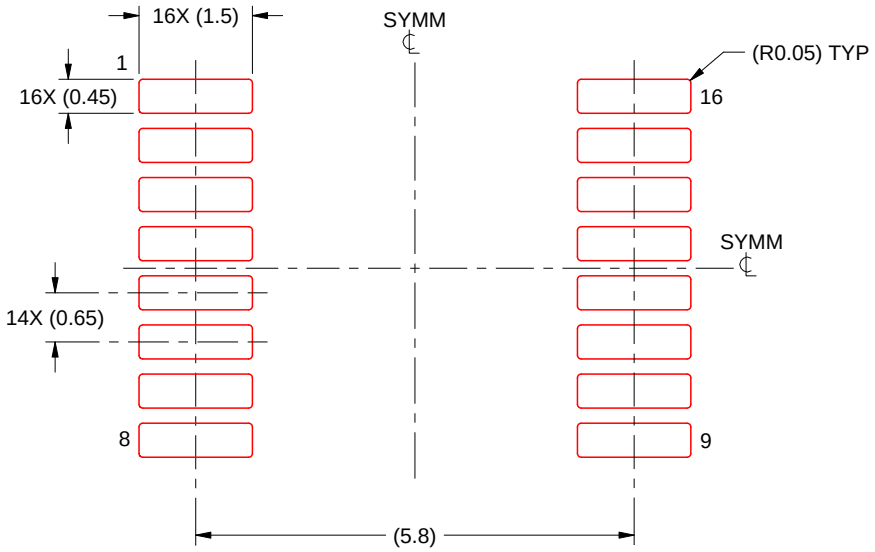
LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

SOLDER MASK DETAILS

4220204/B 12/2023

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220204/B 12/2023

NOTES: (continued)

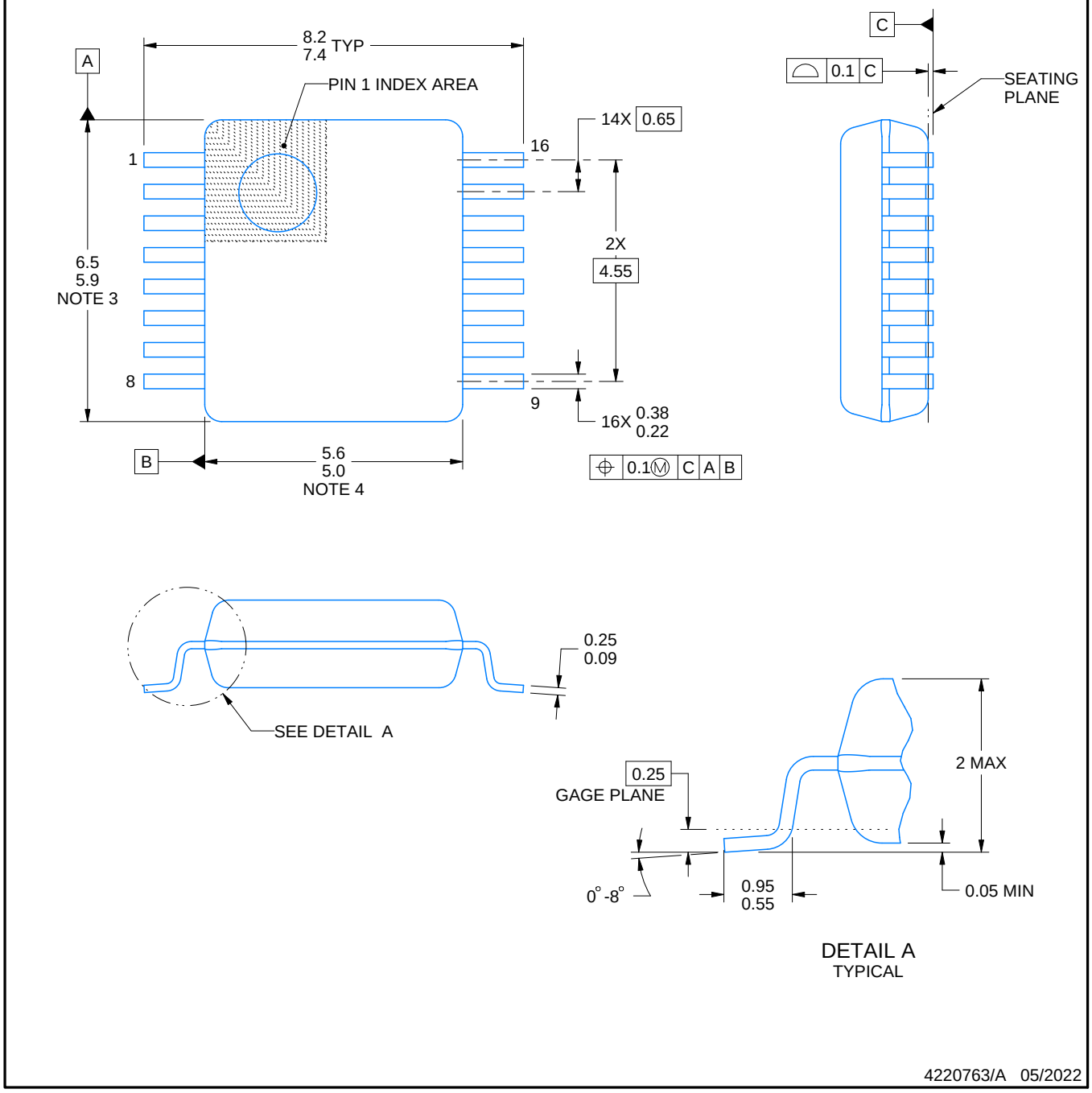
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

PACKAGE OUTLINE

DB0016A

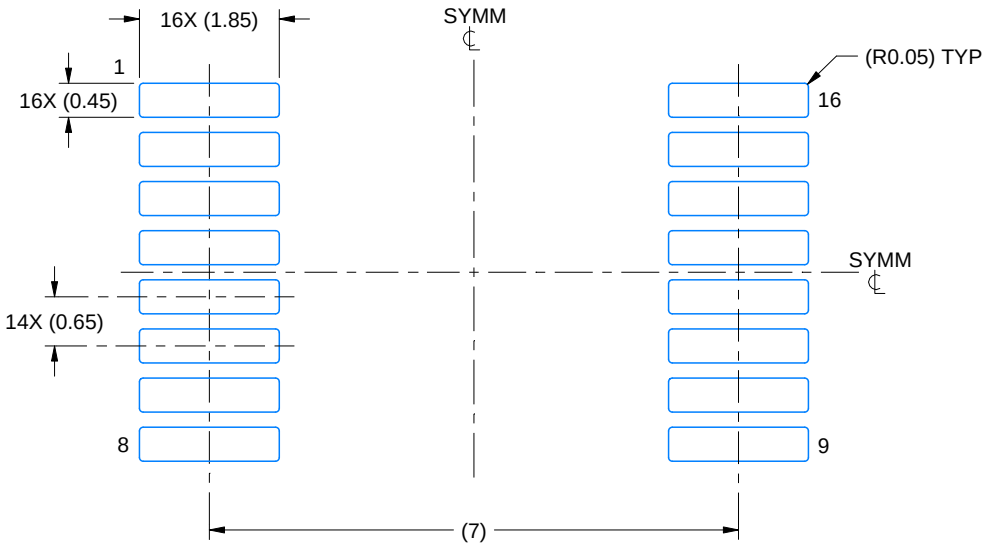
SSOP - 2 mm max height

SMALL OUTLINE PACKAGE

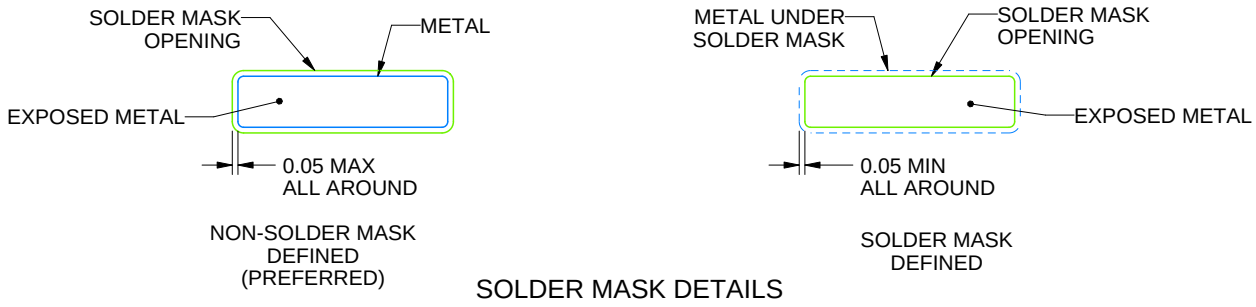


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-150.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

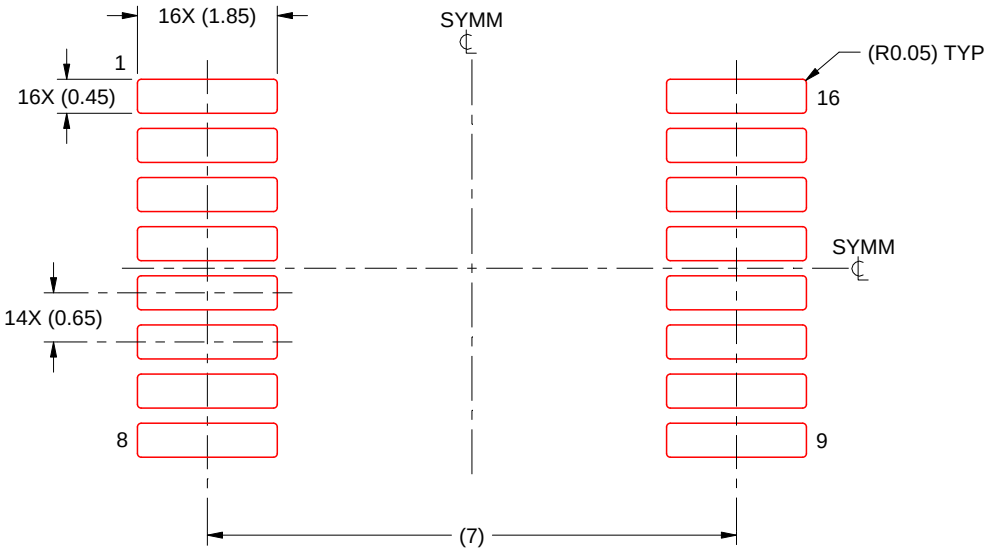


SOLDER MASK DETAILS

4220763/A 05/2022

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220763/A 05/2022

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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最后更新日期：2025 年 10 月